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Indirect estimation of calibration equation parameters for Sentek Diviner 2000 capacitance probe by means of soil physical properties

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Measurements of soil water content (*SWC*) are often used for irrigation scheduling. Accurate monitoring of SWC is necessary, for example, to identify the exact irrigation timing and the amount of water volume to supply according to the crop requirement.

The use of capacitance probes, measuring the apparent soil dielectric permittivity, indirectly related to soil water status, have been increasing during the last decade, as proved by the numerous researches carried out to determine, for different soil types, site-specific calibration relationships between *SWC* and the scaled frequency (*SF*) measured by the sensor. However, for swelling/shrinking clay soils, there is a lack of knowledge on how the changes of soil bulk density associated to variations of soil water content influence the apparent dielectric permittivity and therefore the sensor calibration relationship, as a consequence of the different contribute that soil, water and air, have on the measure provided by the sensor.

The main objectives of the work are i) to determine the site specific calibration equations for a Sentek Diviner 2000 capacitance probe for soils characterized by different texture, ii) to investigate on the effects of soil bulk density and its variability with soil water content, on the calibration equation and iii) to proceed to the indirect estimation of calibration parameters by means of easily-measurable soil physical properties.

Experiments were carried out on nine different soils collected from Sicilian irrigated area, characterized by a clay percentage ranging between 9% and 45%. Undisturbed soil samples (25 cm diameter and 25 cm height), allowed to determine, for each soil, the corresponding site-specific calibration equation. On the other hands, samples having the same dimensions, but filled with sieved soil and compacted at two different bulk densities (ρ_b), were used to investigate on the effects of soil texture and bulk density on the measured *SF*. On each undisturbed or sieved sample and for all the investigated soils, the shrinkage characteristic curve, $\rho_b(U)$ and the *U(SF)* relationship were contextually determined.

The experiments on sieved soil samples, allowed to verify that the scaled frequency measured by the sensor also depends on ρ_b. According to this result, the generally used calibration equation was modified and a new empirical model *U(SF,*ρ_b*)*, introducing the relationship $\rho_b(U)$ as a factor, was proposed. Of course, for swelling/shrinkage clay soil the suggested calibration equation results implicit, if considering that ρ_b is also a function of U.

The experiments also allowed to verify that parameters of the calibration equation depend on soil clay percentage and then to identify empirical relationships for their estimation, that were finally validated by using measurements acquired on undisturbed soil samples and some data collected by the literature.